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ABSTRACT

The amount of print that 42 college students apprehended in 40 millisecond tachistoscopic flash presentations was monitored for strings of random letters, unrelated words, and words in context (sentences). The results indicated that mean apprehension spans per flash were 3.7 letters for random letters, 9.3 letters (2.0 words) for unrelated words, and 11.5 letters (2.4 words) for words in context. These findings were consistent with those of J. M. Cattell, except that Cattell reported a mean of four words for words in context. Although context did not increase apprehension spans as much as Cattell and others have reported, the results do not negate the importance of context in normal reading. The results also indicate a strong positive correlation between the numbers of letters and words correctly and incorrectly identified. This correlation seems to support the "risk taking" hypothesis, which states that better readers will make more errors in an effort to make more correct identifications. (Author/RL)

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APPREHENSION SPAN OF ADULT FLUENT READERS: A CLARIFICATION OF J. M. CATTELL'S CLASSIC RESEARCH ON LETTER AND WORD PERCEPTION

by

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Report from the Project on
Studies in Language: Reading and Communication

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ABSTRACT

This study investigates the amount of print that can be apprehended in 40 millisecond tachistoscopic flash presentations. Strings of random letters, unrelated words, and words in context (sentences) served as test stimuli for 24 graduate students. Results indicated mean apprehension spans per flash of 3.7 letters for random letters, 9.3 letters (2.0 words) for unrelated words, and 11.5 letters (2.4 words) for words in context. These findings were consistent with Cattell's except that he reported a mean of "four words" for words in context. The authors stated that although context was not found to be as powerful a contributor to increasing apprehension span in limited-time reading as Cattell and others have reported, this does not necessarily negate the importance of context in normal reading. Results also indicated a strong positive correlation between the numbers of letters and words correctly and incorrectly identified. This was offered as support for the "risk taking" hypothesis: In an effort to make more correct identifications, better readers will also make more errors.

AN HISTORICAL OVERVIEW

While studying in Leipzig in the 1880's under Wilhelm Wundt, James McKeen Cattell conducted several experiments in the area of visual perception.[1] In one of these experiments (1885a) he investigated the exposure time necessary for perceiving colors, pictures, letters, and words. Cattell constructed a tachistoscopic device (which he labeled a gravity chronometer[2]) that permitted subjects brief, accurately timed exposures to various sets of stimuli. In reporting the letter and word perception tasks, Cattell found: (a) isolated words and randomly arranged letters were identified

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[1]The references in this paper made to Cattell's studies will direct you to the original publications. However, since several of the original studies were published in German and many of the articles may be difficult to retrieve due to their age, we have listed page numbers that correspond to the 1947 compendium of Cattell's work. (A. T. Poffenberger (Ed.). James McKeen Cattell, man of science: 1860-1944 (Vol. 1). Lancaster, Pa.: Science Press, 1947.) Therein you will find all the cited articles, either as they originally appeared (if publisned in English) or translated from German.

[2]The gravity chronometer (which Huey called the "Cattell Fall Apparatus") is a guillotine-like mechanism. A vertically sliding plate with a horizontal opening is released and dropped from varying heights, allowing subjects a brief view of the stimuli (letters and words typed on cards) behind the opening. Exposure time was calculated by considering the size of the opening and the height (and hence speed) from which the plate was dropped. Cattell claimed (1885a, p. 29) that the device was accurate to within .0001 of a second. In later experiments (1886a) Cattell refined the apparatus by including an electromagnet that held the plate up. This permitted smoother release when the current was cut off.

(read) in about the same amount of time (p. 34); (b) not all letters were equally legible (p. 37); (c) three times as many letters could be identified when they made words as when there was no connection (p. 39); and (d) twice as many words could be grasped when they were in context as opposed to random ordering (p. 40).

Various Interpretations of Cattell's Results

Cattell's findings, though not necessarily intended to describe the reading process, have been frequently cited as "proof" of a basic premise of current psycholinguistic literature: Reading requires both visual and nonvisual information. A reader's prior knowledge of and experience with language--supplied in the form of orthographic, syntactic, and semantic redundancy--contributes at least as much to the reading process as the visual input (print).

Cattell's 1885a experiment, as well as other studies he conducted while at Leipzig (1885b, 1886a, 1886b), has been frequently referenced in subsequent reading literature. Huey (1908) described the "Cattell Fall Apparatus" (i.e., the device used in the 1885a experiment) as determining "how much of the line can be read at a single peep" (p. 54). He noted that Cattell found a particular reader who read up to seven words in a single exposure when the

words composed a sentence." Huey qualified this remark, however, by reminding us that Cattell's results illustrated only maximal amounts that could be perceived at a "peep" (p. 62).

Woodworth (1944), supported by Carroll (1972), reported that Cattell has demonstrated that the time required to read a short familiar word was equal to the time needed to read a single letter. This evidence was presented in favor of Cattell's (1885a, p. 34-35) argument for a whole word ("look-say") approach to reading instruction.

Brewer (1972) in response to Gough's (1972) serial theory of word perception cites Cattell's research as showing that:

> (a) Words in prose passages can be read almost as fast as lists of letters. (b) The immediate visual apprehension span for letters in prose is much greater than for random letters. (c) Latencies to initiate pronunciation of words are shorter than those for letters. (d) Visual thresholds for words are lower than the thresholds for letters. (p. 359)

Smith and Holmes (1971) referred to Cattell's other 1885 study (1885b) to reinforce the idea that from a single tachistoscopic exposure, a skilled reader can identify: "(a) four or five unconnected letters; (b) two unconnected words; or (c) four or five words in a meaningful sequence (a phrase or short sentence)" (p. 56). Massaro (1975, p. 380) similarly interprets Cattell's (1886b) research by stating that subjects could read words, phrases, or short sentences when the stimuli were tachistoscopically presented.

Perhaps Frank Smith (1971, 1975, 1978) has been most responsible for popularizing Cattell's work. In Understanding Reading (2nd Ed., 1978, pp 30-31, 153) Smith explicitly describes Cattell's (1885b) "classic study" as a tachistoscopic experiment that showed:

> If random letters of the alphabet were presented . . . then only four or five letters might be reported. But if words were presented, two or three might be reported comprising a total of perhaps 12 letters. And if the words happened to be organized into a short sentence, then four or five words, a total of perhaps 25 letters, might be perceived from the one exposure. (p. 30)

A Confusion of Studies

It is to Cattell's credit that he has been cited by many authors in the past to either describe or substantiate their own interpretations of the reading act. However, upon closer examination of Cattell's experiments, it appears that confusion exists as to exactly what he found regarding identification of letters and words.

Upon review of the frequently cited 1885b experiment (e.g., Smith, 1971, 1975, 1978; Smith & Holmes, 1971), it was noted

that Cattell used a kymograph[3]--not a tachistoscope--to determine the speed with which his subjects could name letters and words. Cattell reported that words in context were read about twice as fast as either unrelated words or random letters (p. 23). (Biemiller, 1978, reported similar findings after testing adults and children.) However, since a kymograph does not necessarily limit a subject to one eye fixation, and only measures reading rate, inferences drawn about the numbers of letters and words that can be perceived in one eye fixation are rather speculative.[4]

It was actually Cattell's 1885a study (which used the tachistoscopic device) that more directly addresses the relationship between visual and nonvisual information with regard to reading. Thus, some of the contemporary interpretations of Cattell's research (e.g., Smith, 1971, 1975, 1978; Smith & Holmes, 1971) seem to be in conflict with Cattell's original

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[3]Cattell's kymograph is a serial exposure apparatus consisting of a vertical rotating cylinder, the speed of which could be variably controlled. A sheet of metal with a horizontal, adjustable opening built into it was used to mask the moving drum. This slit allowed subjects only a limited view of the stimuli (letters and words). The adjustable opening permitted exposure of from one to six letters. Cattell calculated "exposure times" by dividing the number of letters exposed by the speed of the rotation.

[4]The data reported in the 1885b experiment were collected while Cattell was a graduate Fellow at Johns Hopkins (1882-1883). Interestingly, Cattell's subjects for this experiment consisted of fellow graduate students and faculty that included Joseph Jastrow, John Dewey, G. Stanley Hall, and Cattell himself.

findings. In all fairness, however, although both Smith and Holmes refer to the 1885b study and not the 1885a study, their analyses of Cattell's results are reasonable.

Weaknesses in Cattell's Methodology

Upon closer inspection of the 1885a study, however, it was noted that Cattell did not provide any numerical data to support his statements about the effect context has on identification of words. In addition, he reported considerable intersubject variations in performance:

> The determinations made on eight individuals show a considerable personal difference, but an average consciousness can at one time grasp four numbers, three to four letters, or a sentence composed of four words. (39)

Given Cattell's own admission of the subjects' individual differences, coupled with lack of numerical data, small sample size, lack of specific information regarding construction of stimuli, and confusion over the identity of the subjects themselves (Cattell, Dr. Berger, a professor at Leipzig, fellow students, "an educated young lady, a wife of a mechanic, and two rather obtuse porters"), any general statements about Cattell's "findings" regarding the effect of context on limited time word perception are at best tenuous, and at worst scientifically unfounded.

THE STUDY

The purpose of the present study was, therefore, to conduct a highly controlled tachistoscopic experiment investigating the amount of printed material that can be perceived in a single eye fixation. This study would be a modified replication of Cattell's 1885a experiment, thus clarifying some of the many different interpretations (or misinterpretations) of his results.

Since Cattell's report of the experiment offers rather sketchy information about instrumentation and procedure, it was decided to model the present study after Smith's (1978, pp. 30-31, 153) description of Cattell's experiment. Smith describes an experiment in which fluent readers are tachistoscopically presented (50 msec) with three sets of stimuli: (a) strings of random letters (about 25); (b) sets of unrelated words (four to six words, totaling about 25 letters); and (c) words in context (meaningful phrases or short sentences, again totaling about 25 letters). Subjects were directed to orally report as many letters (or words) as possible. It was the purpose of the study, therefore,

to determine whether fluent readers will be able to apprehend[5] more printed material when letters are arranged into words than when they are in random order, and if even more print yet will be apprehended when the words are contextually arranged.

In addition to determining the apprehension span for letters, unrelated words, and words in context, the present study also investigated "risk-taking" ability in fluent readers. Smith (1978, p. 22) hypothesizes that fluent readers are willing to take greater risks in reading than less able readers; that is, their criterion levels for word and meaning identification are not so high to inhibit them from predicting subsequent letters, words, and meanings. (This research topic stems from signal detection theory; e.g., Swets, 1973; Swets, Tanner, & Birdsall, 1961). Therefore, one would expect the greatest risk-takers (those making the most errors) to also make the most correct identifications of random letters and words.

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[5]The word apprehend (to grasp the meaning of; understand; conceive) is used rather than "identify," for we would not maintain that individual letters need be identified to read words. Erdmann and Dodge (1898) found that whole words could be read before their individual letters could be identified, and that phrases or sentences could be read before the individual words. The amount of visual information per eye fixation remains constant whether one looks at random letters, unrelated words, or words in context. Any ability to apprehend (read) a greater volume of letters under these circumstances cannot be attributed to additional visual information, but rather to nonvisual information--the reader's knowledge of regularities (redundancies) of language. In effect, what the study measures is a fluent reader's ability to apply this nonvisual information to the reading task. It is just for convenience that the dependent variable (a fluent reader's apprehension span) is measured in total letters.

Hypotheses

More formally stated, the present study tested the following hypotheses:

H_1: Fluent readers will apprehend more letters when they are arranged in unrelated words than when in random order.

H_2: Fluent readers will apprehend more words when they are in context than when in random order.

H_3: For fluent readers, a relationship exists between the numbers of letters and words correctly identified and the numbers of letters and words incorrectly identified.

Method

Subjects

Subjects were 24 volunteer, graduate students in education at a major university.

Apparatus

A #3 Universal Tachistoscope (Rochester, New York) was mounted on the lens of a Sawyer 2 X 2 slide projector. The exposure time was set at 1/25 second (40 msec) and was maintained throughout the experiment. The testing room was slightly illuminated by directing a study lamp toward the back of the room. A comfortable flash luminosity was determined and the tachistoscope aperture was fixed.

The slide projector was situated 12 feet from a Da-Lite (model B) screen.

Stimuli

Three different sets of stimuli were developed by the researchers: sets of random letters, sets of unrelated words, and sets of words in context (see Appendix A for a complete list).

Random letters. Ten strings of 25 random letters each were developed by sampling with replacement from a pool of letters reflecting letter frequencies in English words (Mayzner & Tressalt, 1965).

Unrelated words. Ten strings of unrelated words, totaling 25 letters per string, were drawn from the top 5,000 words in the rank list of the Word Frequency Book (Carroll, Davies, & Richmann, 1971). Words ranged from two to seven letters in length (mean = 4.7 letters), and each set consisted of from four to six words (mean = 5.3 words).

Words in context. Ten strings of words in meaningful context (sentences) were chosen in the same manner as the strings of unrelated words. The strings of words in context matched the strings of unrelated words according to word length, speech part, and word frequency (matched words were taken from the same vicinity in the Word Frequency Book). The only difference between the two sets of words was the presence or absence of context. It should be noted, however, that the context was only designated

within the sentences and not across them; that is, the 10 sentences did not constitute a coherent passage.

Letters appearing in the strings of unrelated words and words in context also closely matched the English frequency criteria used in constructing the strings of random letters. Thus, all three sets of stimuli consisted of 10 strings of 25 letters reflecting English letter frequency counts. The only difference among the three sets of stimuli was the addition of orthographic regularities (in the case of the unrelated words), and the inclusion of orthographic regularities and context (for the sentences).

Production of the slides. All strings of letters and words were typed in elite type on clay-based paper with an IBM Selectric II typewriter. All but the beginning letters of the sentences were typed in lower case letters. Letters were single spaced with double spacing between words. Punctuation marks were included at the end of each sentence.

The 30 strings were professionally photographed using Kodak Kodalith film and mounted as individual slides. Each slide when projected produced a distinct white-on-black image.

Procedure

Subjects were seated at a table 12 feet from the screen. Stimuli were flashed above a lightly contrasting green line that was taped to the screen. This gave the subjects a vertical point of reference. A black spot in the center of the green line marked the middle of each string.

Subjects were directed to read as many letters (for the strings of unrelated letters) or words (for the unrelated words and words in context) as possible and report them orally. For the random letters, subjects were asked to fixate in the middle (at the black spot) of each line. This made scoring easier, since judgements about correct/incorrect letter identifications would be difficult to make if the viewing area was unknown. It was stated, however, that letters (or words) need not be reported in the same left to right order they appeared on the screen. For the unrelated words and words in context, subjects were told to look at the portion of the line they deemed as comfortable, instead of focusing on a specific point.

The verbal cue, "Ready, set" was given before each presentation to alert subjects to the following flash. One experimenter operated the slide projector and tachistoscope while the other experimenter recorded responses on a printed code sheet.

All three sets of stimuli were counterbalanced in the six possible orderings. Two practice slides for each set of stimuli were presented prior to administering the test stimuli. Subjects were allowed as much time as necessary between flash presentations. Administration time typically took about 10-15 minutes per subject.

Scoring. All data were tabulated in three forms: (a) numbers of letters correctly identified (per item, stimulus set, and subject); (b) numbers of letters incorrectly identified (per item, stimulus set, and subject); and (c) total responses

(correct plus incorrect, per item, stimulus set, and subject). A predetermined set of criteria for scoring was as follows:

1. For the strings of random letters, only correctly identified letters within three letters in either direction of the correctly identified cluster were scored as correct. For example, if the subject responded "ecoew" for the string ". . . iyecoefwaog . . .," credit would be given for five letters. If the subject responded "ecoeo" for the same string ". . . iyecoefwaog . . .," four letters would be counted as correct, one as incorrect, with a total response of five letters.

2. For the sets of unrelated words and words in context, the number of letters in correctly identified words was converted to letter counts. Partial credit was given for correctly identified word parts. For example, if the subject responded "his answers" to the stimuli ". . . him answer . . .," it was scored as: eight letters correct (hi . . . answer), two letters incorrect (s,s), with a total response of 10 letters.

Each experimenter independently scored all 24 code sheets. When a discrepancy in scoring occurred, the items in question were reviewed by the experimenters and rescored.

Results

Apprehension Span

Table 1 displays mean scores and standard deviations of number of letters apprehended across the three treatments. The maximum possible score per condition is 250 (25 letters per string times 10 strings), and the maximum column total is 750. It is apparent that subjects were able to apprehend many more letters as they became orthographically and contextually meaningful. In fact, the data

Table 1

Mean Number of Letters Correct, Incorrect, and Total Responses by Treatment Groups (Standard Deviations in Parentheses)

Conditions[a]	Correct	Incorrect	Totals
Random letters	37.2 (7.5)	3.5 (2.8)	40.7 (12.8)
Unrelated words	92.5 (17.8)	7.3 (8.6)	99.8 (23.8)
Words in context	115.2 (28.7)	6.7 (6.7)	121.9 (32.5)
Total letters	244.9 (50.4)	17.5 (14.8)	262.4 (61.7)

Note. Maximum score per condition = 250.

Maximum score per column totals = 750.

[a] n = 24 for each condition.

were quite consistent and reflect a linear trend, except the unrelated words elicited more errors than the words in context. Within the framework of a mixed model (Hays, 1973, pp. 568-574), an analysis of variance with repeated measures was performed on correct and incorrect responses. In the present study, the subjects are treated as random effects and the conditions as fixed effects.

Correct responses. With alpha level set a priori at .05, analysis of variance for letters correct (see Table 2) indicated statistical significance due to conditions, $F(2,46) = 212.44$, $p < .0001$. Post hoc comparisons using Tukey's procedure revealed significance for all three comparisons: random letters versus unrelated words, $F(2,46) = 20.10$, $p < .0001$; random letters versus words in context, $F(2,46) = 28.35$, $p < .0001$; and unrelated words versus words in context, $F(2,46) = 8.23$, $p < .0001$.

Incorrect responses. With alpha level set at .05, analysis of variance for letters incorrect (see Table 3) also revealed statistically significant results, $F(2,46) = 3.58$, $p < .05$. Post hoc comparisons revealed significance only for the random letters versus unrelated words comparison, $F(2,46) = 3.54$, $p < .05$.

"Risk-Taking" Ability

Results indicated that a relationship exists between the numbers of letters and words correct and incorrect. Pearson product moment correlation coefficients comparing correct and incorrect responses

Table 2

Analysis of Variance for Letters Correct

Source	SS	df	MS	F
Between subjects	20283.28	23		
Within subjects	85741.34	48		
Treatments	77365.37	2	38682.69	212.44*
Residual	8375.97	46	182.09	
Total[a]	106024.62			

[a]Between subjects + Within subjects.

*$p < .0001$.

Table 3

Analysis of Variance for Letters Incorrect

Source	SS	df	MS	F
Between subjects	1758.00	23		
Within subjects	1494.00	48		
Treatments	201.33	2	100.67	3.58*
Residual	1292.67	46	28.10	
Total[a]	3252.00			

[a]Between subjects + Within subjects.

*$p < .05$.

indicated positive correlations for all three sets of stimuli: random letters, r = .58; unrelated words, r = .57; and words in context, r = .50. A comparison of total letters correct and incorrect summed across all conditions produced a correlation coefficient of .70.

Table 4 presents means of correct and incorrect responses grouped into thirds by rank ordering subjects according to total number of correct responses. With respect to the top third (eight subjects), it is apparent that this group not only made the most correct responses, but the most incorrect responses as well.

DISCUSSION

Apprehension Span

The data clearly indicate that adult fluent readers apprehend many more letters when they are organized into unrelated words than when presented in random order, and that apprehension span is even greater when the words are contextually meaningful. These findings support hypotheses one and two and are in partial agreement with Cattell's (1885a) results and Smith's (1971, 1975, 1978) interpretations of them. Results indicated that an average of 3.7 letters were apprehended per flash when presented in random order, and an average of 9.3 letters (2.0 words) were recalled when

Table 4

Means of Correct and Incorrect Responses Grouped into Thirds by Rank Ordering Subjects According to Total Correct Responses

Subjects	Random letters[a]		Unrelated words		Words in context		Total responses	
	C[b]	I[c]	C	I	C	I	C	I
Top third	45.0	5.3	109.4	15.5	145.5	13.0	299.9	33.8
Middle third	33.9	2.1	91.0	2.9	109.8	3.8	234.6	8.8
Bottom third	32.6	3.1	77.3	3.6	90.4	3.3	200.3	10.0

Note. Maximum score for Random letters, Unrelated words, or Words in context = 250. Maximum score for Total responses = 750.

[a] $n = 24$.

[b] Letters correct.

[c] Letters incorrect.

stimuli were fashioned into a series of unrelated words. (These averages were computed by dividing the means of correct responses by 10; see Table 1. The letter count can be converted to words by dividing by 4.7, the mean number of letters per word.) These results correspond proportionately to the "two to three letters" and "two words" that Cattell reported, and the "four or five letters" and "ten to twelve letters" that Smith proposed could be read in one eye fixation under these conditions. Apprehension span for words in context, however, averaged only 11.5 letters (2.4 words) as compared to the "four words" Cattell reported and the "four or five words" Smith insists can be read.

Although the present study lends support to the psycholinguistic principle that orthographic and contextual regularities permit increasingly greater apprehension spans in reading, the results do not indicate that context contributes as much to this increased apprehension span as has been previously stated. In other words, the results are not in complete agreement with Cattell's findings and conflict to some extent with popular thought concerning the impact context has on apprehension span.

"Risk-Taking" Ability

The results of the experiment also verify that a relationship exists between the amount of print apprehended and the number of

errors made in responding (r = .70 for total letters correct and incorrect across all conditions). This substantiates hypothesis three and also Smith's (1978) contention that better readers will not only be "right" more often than less able readers, but they will also make more "errors." As Smith states: "The more often you want to be right, the more often you must tolerate being wrong" (p. 21).

LIMITATIONS

Although the results of the present experiment credit fluent readers with the ability to supplement the visual stimuli of print with their knowledge of language, generalizing this information to other reading tasks and to other groups of readers should be done with caution. The use of a tachistoscope permitted measurement of the amount of print that can be perceived in one eye fixation, but normal reading, of course, does not take place under these conditions. Since most adult readers make four to six eye fixations per second (Tinker, 1958), individual words and phrases can be scanned several times before they are actually identified. (Hence the term "eye-voice span"; Gibson & Levin, 1975). In fact, the relatively small increase in apprehension span with the addition of context in the experiment may be explained by the reader's inability to "re-view" the print.

A more basic issue is whether committing a wholistic process such as reading to a scientifically imposed framework does, in effect, create confusion. Fragmenting the reading act in order to isolate visual/nonvisual interaction of specific components may obscure the essence of the whole. Thus, questions concerning the efficacy of conclusions drawn may be justified.

Other limitations of the present study involve the differences between mature and beginning readers. Since the subjects were all adult fluent readers, inferences about performance of less able subjects cannot be accurately drawn. It may be the case, for example, that poor readers rely more upon visual information. Thus, providing additional deep structure clues in the form of orthographic and contextual regularity may prompt little improvement in increasing apprehension span for this population.

It may also be true that the risk-taking phenomenon is unique to highly skilled readers, or only functions as a profitable meaning-getting strategy at a specific stage of reading competence. Additionally, the weight of prior experiences, both instructional and noninstructional, may have interacted more with subjects' performances than was apparent. In the sentence, "Her father had dark brown eyes," several subjects misread "dark" as "drank." Although the nature of this error may have been due more to configuration similarity than to some unexplained "trigger" in prior memory, the significance of previous nonlinguistic experience upon meaning brought to print should not be underplayed. Individual

knowledge plus style of learning cannot be discounted as variables which may have influenced the behavior of certain subjects.

IMPLICATIONS

Future research of similar design with poor adult readers and children of varying reading abilities might provide additional information as to which components of the reading process most greatly influence apprehension span.

Further study into the role context plays in limited-time reading is also warranted. It is suspected that context contributes more to the deep structure information gleaned in print than the present study has shown. Perhaps if the stimuli constituted related sentences instead of independent strings or were organized into small "chunks" of meaning, the effect of context upon apprehension span would have been more dramatic. It would also be interesting to determine if differing grammatical constructions, parts of speech, or word lengths encourage or discourage apprehension span. With respect to syntax, one wonders how much of an effect reducing syntactic complexity has upon acquiring meaning through print. One theoretical standpoint maintains that increased sentence complexity and/or length may actually equip the reader with extra opportunities to employ reading strategies. Conversely, grammatically difficult structures may serve to impede semantic understanding, thus minimizing the

efficient use of contextual aids. Exactly how syntax functions in the use of tachistoscopically controlled reading remains unresolved.

Research involving the manipulations of readers' criterion levels for word and meaning identification might also prove fruitful. Furniss (Note 1) found that the oral reading rates of adult subjects, plus the types of errors they made were swayed by the particular directions they had been given prior to the reading task; that is, whether they were encouraged or discouraged from "taking risks" in their reading. The present study just barely explored the issue of risk-taking ability, thus further investigation, especially with children, is needed. If indeed it can be assessed that children who are poor readers are also poor riskers, as Smith (1978, p. 22) maintains, and it is determined that this contributes to their lack of success in reading, the implications for instructional methodologies and materials are vast.

And finally, perhaps a "lesson" can be learned from the present research: Researchers should more critically review classic psychological studies and be more cautious in drawing implications from them. Although the contributions made by historical scientific figures like Cattell are unquestionably great in magnitude, one must consider the differing levels of scientific rigor between classic and current behavioral research. Due to a

combination of lack of accurate physical apparatus and knowledge of modern research design and statistical procedures, the precision of classic research does not compare to that of current experimentation. Consequently, interpreting classic studies as though they were contemporary can be dangerous. We believe that for the present example of Cattell's research in letter and word perception, this has been the case: Greater inferences have been drawn from his research than can be logically justified. Obviously, the responsibility lies with the reader of research to ascertain what implications can be justifiably drawn from particular studies. We believe that in the present case, scientific writers have been overzealous in their desire to fit research to theory rather than the opposite.

In summary, classic research has a great potential value, but one must consider the time and circumstances under which the research was conducted when reading such investigations. In many cases, careful examination will reveal methodological flaws (by contemporary standards) and inferences will have to be tempered. Consequently, we believe that in many instances, replication of classic research is appropriate; this certainly applies in the present context.

Reference Note

1. Furniss, D. Externally imposed criteria and reading performance. Manuscript submitted for publication, 1978.

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Appendix A

Test Stimuli

Random Letters

1. oaneuldriyecoefwaoqrormns
2. glofaucausmpoahlseoveated
3. aykhrneshumeuihefkbiirrtn
4. wvooldnwpthdclxtwrfeahegw
5. efuundtamtshetbstoenhhavd
6. vdtooundnrntafsupelwxlaeo
7. ilbttbkehnnemglwpxedffnmt
8. httvethodoauflchaephnhyai
9. danthagcnahwotlncwroqjhte
10. atiiaeshpilsaepcuethobmop

Unrelated Words

1. floor parked over warm houses
2. homes earn cave already at lay
3. an farmers be begins on tribes
4. would person point what paper
5. animal yelled shaded pattern
6. give small used tree our since
7. which plants can human around
8. front measure work many first
9. him answer may fine clean days
10. his today more trouble apples

Words in Context

1. Ships sailed into deep waters.
2. Women hang wash outside to dry.
3. My brother is afraid of trains.
4. Could mother learn this story?
5. Winter brings colder weather.
6. Read every good book two times.
7. Their family has seven people.
8. Close friends help each other.
9. Her father had dark brown eyes.
10. She heard some strange voices.